

MEDICAL STAFF CONFERENCE

Heart Disease in Patients With Thyroid Dysfunction

These discussions are selected from the weekly staff conferences in the Department of Medicine, University of California Medical Center, San Francisco. Taken from transcriptions, they are prepared by Drs. Martin J. Cline and Hibbard E. Williams, Associate Professors of Medicine, under the direction of Dr. Lloyd H. Smith, Jr., Professor of Medicine and Chairman of the Department of Medicine.

DR. SMITH:* As physicians we are interested in reversible and treatable forms of heart disease. We have decided to present two patients who represent two diametrically opposite kinds of endocrine dysfunction to illustrate the effect of thyroid disease on cardiac function. These two patients, who were admitted to the medical service a few months ago, illustrate quite nicely the effect of endocrine therapy on the reversal of heart disease. The first patient will be presented by Dr. Oscar Scherer.

DR. SCHERER:† The patient is a 56-year-old, Caucasian woman who entered the hospital because of chest pain and fatigue. At the age of 10 she had been admitted to San Francisco General Hospital because of what appeared to be diphtheria with cardiac involvement. At age 19 she had episodes of syncope related to both fast and slow heart rates. Because of "cardiac" complications during pregnancy at ages 32 and 35 cesarean section was carried out, and normal babies were delivered. At age 38, after her first episode of chest pain, she was told she had had a "heart attack," although she was not put into hospital and an electrocardiogram was not made. At age 40 she was given thyroid ex-

tract, 100 mg a day, although no laboratory studies were performed. In 1963 at the age of 52, left ankle and groin dissection was performed for a malignant melanosarcoma without metastasis. There has been no recurrence of this tumor. The butanol extractable iodine (BEI) was 3.0 $\mu\text{g}/100\text{ ml}$ and triiodo thyroxine (T_3) uptake 13 percent at that time. One year before hospital admission the PBI and BEI were 6.0 and 4.4 μg per 100 ml respectively.

Six weeks before hospital admission she experienced increased nervousness and chest pain. At this time chest x-ray was within normal limits and thyroid medication was discontinued. One month later she was seen in the Emergency Room complaining of fatigue, cold intolerance, a weight gain of ten pounds and shortness of breath. Physical examination at that time revealed no signs of congestive heart failure or cardiac tamponade. The chest x-ray demonstrated cardiomegaly, bilateral pleural effusions and questionable pericardial effusion. Electrocardiogram showed low voltage; PBI was 1.8 μg and BEI 0.9 μg per 100 ml. The patient refused hospital admission and administration of triiodothyronine was begun, starting with 5 μg a day and increasing to 25 μg a day during the subsequent two weeks. After this two-week period of treatment

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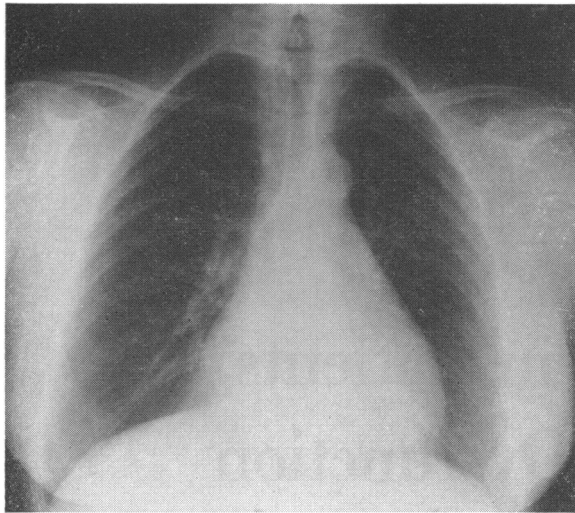


Figure 1—Chest radiograph of first patient taken at time of admission to hospital.

she was admitted to hospital. An x-ray film of the chest was normal and 24-hour radioactive iodine uptake was 3 percent. After four days of treatment with thyroid stimulating hormone, radioactive iodine uptake was 2 percent.

Thyroxine was begun at 0.05 mg a day and was slowly increased to 0.125 mg a day. The most recent PBI determination was 5.8 μ g per 100 ml. X-ray films of the chest remained within normal limits. The patient continues to have atypical chest pain.

DR. SMITH: Could we see the x-ray films?

DR. YOUKER:* The first film of the chest, taken six weeks before admission to hospital, was within normal limits. A month later an increase in the cardiac size was noted (Figure 1) with a somewhat lobular configuration of the heart suggestive of pericardial effusion. There is no evidence of pulmonary vascular congestion. However, on the lateral film, blunting of both posterior costophrenic sulci is apparent and lateral decubitus films demonstrate small pleural effusions as well. A follow-up film after treatment showed a return of the cardiac silhouette to normal size and disappearance of the pleural effusions.

DR. SMITH: The patient is here for presentation. (Patient enters.) We appreciate your coming here to meet the doctors who want to hear about your problem. How are you feeling?

Patient: I have a cold.

DR. SMITH: Have you improved since you were here this summer?

Patient: Yes, my heart problem has improved.

DR. SMITH: What changes have you noticed?

Patient: Well, I can do a bit more without having a choking feeling and my strength has improved. Also I do not have to take nitroglycerin as much as I did. But I will say that I am not as good as I was last year.

DR. SOKOLOW:* Have you noticed any change in the speed with which you can do things? For instance, can you get dressed more rapidly?

Patient: Yes.

DR. SOKOLOW: Do you notice any more ease in doing things with your hands, such as sewing or using your fingers?

Patient: Not much.

DR. SMITH: She is on full thyroid replacement treatment now. Are there any other questions? Thank you very much for coming by to see us again. (Patient leaves.) The second patient will be presented by Dr. William Rutherford.

Presentation of Second Case

DR. RUTHERFORD:† The patient is a 68-year-old, white, married woman who entered the University of California Medical Center because of swelling of the feet and legs of five months' duration. The past medical history is significant in that she had an episode of rheumatic fever at age 18, requiring one year's bed rest. There was no known heart involvement with this episode. However, at age 40 she was refused government employment because of a cardiac murmur. At age 65, she was forced to retire from her usual work as a waitress because of easy fatigability. During the two years before hospital admission she had had frequent chest colds, with nonproductive cough. Seven months before hospital admission she noted dyspnea, weakness and increasing orthopnea. Five months before admission to hospital she noted peripheral edema and the gradual onset of profuse night sweats requiring two to three changes of clothing a night. Treatment with a thiazide diuretic led to improvement in the edema but had no effect on the shortness of breath.

On physical examination at the time of admission the patient appeared to be in mild respiratory distress. Blood pressure was 150/80 mm of mer-

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cury, pulse 116 per minute, respirations 24 per minute and temperature 38.2°C. The skin was fine, moist and warm, with very fine hair. The thyroid gland was full and smooth and the neck veins were distended to the cricoid cartilage at 30° elevation, with normal venous pulsation. On examination of the heart the point of maximum impulse was noted to be 1 cm medial to the anterior axillary line. There was a left ventricular thrust, and a right ventricular heave; no thrill was felt. The first heart sound was normal, the pulmonary component of the second sound was greater than the aortic component. A third sound was heard at the left sternal border. The following murmurs were heard: grade II/VI systolic at the apex with radiation to the left sternal border and axillary line; grade III/VI systolic ejection murmur at the base, radiating to the neck; grade II/VI diastolic blowing murmur at the left sternal border, and a questionable soft diastolic rumble at the apex. Scattered expiratory wheezes and rhonchi were heard throughout the chest. There were no rales. The liver edge was not felt and there was a trace of peripheral edema.

Laboratory examination: Hematocrit, 39 percent; leukocytes, 9,800 per cu mm—50 percent polymorphonuclear cells, 1 percent eosinophils, 46 percent lymphocytes and 3 percent monocytes. The sedimentation rate was 78 mm in one hour. An electrocardiogram demonstrated a sinus tachycardia with moderate left ventricular hypertrophy. BEI was 11.1 µg per 100 ml, cholesterol 137 mg per 100 ml, T₃ uptake 44 percent, and I¹³¹ uptake 20 percent at 1½ hours, 50 percent at 5 hours and 63 percent at 24 hours. A thyroid scan revealed findings consistent with a diffuse toxic goiter.

The patient was treated with 7.5 millicuries of I¹³¹ and reserpine, phenobarbital and propylthiouracil, and the cardiac symptoms abated.

DR. SMITH: The patient is here for presentation. (Patient enters.) How are you getting on now?

Patient: Pretty well.

DR. SMITH: What changes have you noticed since you were in the hospital?

Patient: Well, I can walk now without resting as frequently, and my breathing is much better.

DR. SMITH: Have you noticed any changes in sleeping, nervousness or tolerance to heat?

Patient: Everything is much better. My weight is about ten pounds less than it was.

DR. SMITH: Dr. Sokolow, would you like to mention anything?

DR. SOKOLOW: Have you noticed any change in your reaction to the weather in the last two months? When you first came here, did you have any unusual susceptibility to warm or cold weather?

Patient: I wasn't aware of any.

DR. SOKOLOW: Has anyone made any comment about your hands?

Patient: They don't shake as much.

Question from the audience: Has there been any change in the heart murmurs?

DR. SMITH: The diastolic murmur remains but is less prominent.

Thank you very much for coming. (Patient leaves.)

Here then, are two patients who have come to us in the past two months with underlying heart disease but who had superimposed complications relating to thyroid dysfunction. We have asked Dr. Maurice Sokolow to comment on the influence of thyroid dysfunction on the manifestations of heart disease.

Discussion

DR. SOKOLOW: I saw both of these patients on the same afternoon, and it struck me at the time that although there was considerable similarity between the two, in that they both had shortness of breath, nervousness and chest pain, there were striking contrasts in that one was obviously hypothyroid and the other was hyperthyroid. As Dr. Smith has said, both these conditions are potentially curable and since we now have precise techniques for determining the state of thyroid function, the physician must exclude both of these conditions in patients with heart disease. I will not discuss the laboratory or biochemical manifestations, but will confine my remarks to the clinical aspects of thyroid heart disease.

The circulatory accompaniments of the excess production of thyroid hormone produce symptoms and signs which often are confused with cardiac disease. The increased oxidative requirements of the patient who has an enormous increase in metabolic rate require that cardiac output and peripheral blood flow be increased. This increase in cardiac output and blood flow produces a combination of symptoms and signs that suggest the presence of heart disease. That is, patients may have tachycardia, peripheral vasodilatation, sweat-

ing, systolic hypertension with increased pulse pressure, a rapid upstroke of the carotid pulse, and flow murmurs in the heart. If there is underlying heart disease, then the manifestations of cardiac involvement are even more pronounced and it is difficult to separate the effect of cardiac disease from the effect of circulatory hyperactivity produced by the increased metabolic rate. There has been a good deal of controversy in the literature as to whether thyrotoxicosis can cause cardiac failure, and there are many arguments pro and con. I will elaborate as we go on.

From Sheffield, England, Sandler and Wilson,⁶ reported a study of 462 patients with thyrotoxicosis, of whom 150 had cardiac involvement. They divided the patients into those who had associated heart disease and those who did not. Although there was a large number of patients with cardiac involvement who had no obvious heart disease when they presented themselves, the majority had ischemic or hypertensive heart disease and a smaller proportion had rheumatic heart disease. Nearly half of the patients with cardiac involvement had no evidence of associated heart disease. The remaining half had underlying heart disease in which the extra load from increased cardiac output might be expected to precipitate cardiac difficulty.

Atrial Fibrillation

Sandler and Wilson showed a very striking relationship between age and the prevalence of atrial fibrillation and cardiac failure. The fact that both fibrillation and cardiac failure are uncommon below the age of 40 has been one of the strongest arguments that thyrotoxicosis does not cause heart failure. The progressive increase in the prevalence of both atrial fibrillation and congestive failure with increasing age suggests that thyrotoxicosis unmasks subclinical coronary or other degenerative heart disease but does not *per se* cause heart disease.

Atrial fibrillation is related not only to age, but also to the presence or absence of cardiac failure. As the incidence of atrial fibrillation increases, so does that of congestive heart failure. The importance of atrial fibrillation in producing dilatation and hypertrophy of the heart in cardiac failure has always been appreciated in patients with rheumatic heart disease. Levine, in particular, emphasized that atrial fibrillation, even in the absence of heart disease, and in the absence of thyrotoxicosis may lead to cardiac hypertrophy and failure. Ap-

parently the presence of atrial fibrillation is particularly serious to older patients with thyrotoxicosis.

Overlooked Thyrotoxicosis

The diagnosis of thyrotoxicosis is often overlooked in patients with atrial fibrillation and cardiac failure. The causes of this diagnostic error may be divided into three major categories.

1. The cardiac manifestations may overshadow the clinical picture of thyrotoxicosis. When the second patient under discussion today was presented to me as an example of rheumatic heart disease I was impressed by her very warm, moist hands. In addition, her movements were relatively quick for a patient with heart failure. (They were a good deal quicker than they are today.) Although she had then the symptoms of dyspnea and edema, there was a disparity between her vigor and her symptoms and signs of heart failure. It was this that led me to suspect hyperthyroidism. I think the manifestations of hyperthyroidism are usually present in these patients, but they are often overlooked because of the dominance of the cardiac symptoms.

2. Some patients present with a clinical picture referred to as "apathetic thyrotoxicosis." When the patient really has atypical features, some of the classic manifestations of hyperthyroidism are absent. Instead of being excited and nervous, these patients may be subdued and apathetic. There appears to be a disparity between the apathetic facies and hyperactive movements, which may be noted in many of these patients on careful examination. I have found that comparing the movements and the apparent well-being of the patient with the extent of the symptoms is often helpful. Patients who have apathetic facies may have tremor. The patients I have seen appear less often to have tremor with apathetic facies and more often to have hyperactive movements. Levine has commented on the very quick movements of patients with thyrotoxicosis, even if the other manifestations are absent. The so-called "salmon skin" which Levine has emphasized, with hyperemia and increased peripheral blood flow, is often a helpful sign. It was present in the second patient presented today.

3. Cardiac manifestations, mainly atrial fibrillation, may precede the other clinical manifestations of thyrotoxicosis by months or years. On several occasions we have received credit for an

astute diagnosis of thyrotoxicosis in patients with cardiac symptoms present for several months, often after the diagnosis had been excluded earlier in the course of the disease. It is important to emphasize that such patients require careful observation and repeat studies for thyroid disease long after the initial appearance of atrial fibrillation.

The term "masked hyperthyroidism" has been used by Levine to describe a particular condition in persons in whom the hyperthyroidism is not obvious. It was once said that the diagnosis was only masked in the eyes of the physician, not in the patient. The diagnosis of thyrotoxicosis should always be suspected in patients with unexplained atrial fibrillation or congestive heart failure poorly responsive to digitalis therapy or in patients with systolic hypertension with a wide pulse pressure disparity and a normal or short circulation time. This latter finding is in contrast to the delayed circulation time usually seen in patients with cardiac failure.

Evidence of a raised cardiac output including vasodilatation and warm, moist skin is important in differentiating thyrotoxic patients from those with anxiety states, in whom there may be increased sweating but cold and moist skin. Other manifestations of hyperthyroidism, such as unexplained weight loss and diarrhea, may be helpful diagnostic clues. Photomotograph measurement of reflex activity may be helpful but in my experience it is less so than in hypothyroidism. Sleeping tachycardia—a finding present in the second patient presented today is important.

The early diagnosis of thyrotoxicosis may influence the subsequent therapeutic results. Sandler and Wilson⁶ emphasized that the response to treatment is not as dramatic in thyrotoxicosis as in myxedema, and may be much less than satisfactory. Twenty percent of the patients they studied died of congestive heart failure within one to seven years after therapy; complete relief of symptoms occurred in only 40 percent. They also demonstrated that survival and the relief of cardiac failure were directly related to the disappearance of atrial fibrillation after treatment. In patients in whom sinus rhythm followed treatment with radio-iodine, no deaths occurred and all patients with cardiac failure were improved. In patients in whom atrial fibrillation persisted, 20 percent died and striking clinical responses were correspondingly less. In studying this report it struck me that one reason for the persistence of atrial fibrillation in so many

patients may have been the authors' fear of using quinidine. Their studies were done before the availability of electrical cardioversion for the treatment of cardiac arrhythmias and they considered congestive heart failure to be a contraindication to quinidine therapy. Hence quinidine was not used to revert the atrial fibrillation to sinus rhythm, and I think that was an error which we would now appreciate. If atrial fibrillation persists after treatment of thyrotoxicosis with radio-iodine, electrical cardioversion should be employed in an attempt to establish normal sinus rhythm.

In summary, the early diagnosis of thyrotoxicosis is important in the prevention of cardiac failure and a poor therapeutic response to radio-iodine.

Heart Disease and Hypothyroidism

Turning to a consideration of the first patient presented today, we encounter a situation in which a good deal of controversy has taken place. A difference of opinion has arisen primarily because there are those who believe that myxedema causes cardiac failure, and there are others who argue that the induction of myxedema has been beneficial in the treatment of congestive failure.

The paradox presented by these differing views may be explained by the fact that myxedema does not cause cardiac failure but does cause pericardial effusion, and pericardial effusion is often confused with cardiac failure. There are many cardiac symptoms and signs in myxedematous patients which suggest the presence of cardiac failure. "Myxedema heart" is a well-known entity described by Zondek in 1918. Fahr⁷ in Minneapolis was the first to comment that patients with this syndrome have cardiac failure. His conclusions were based almost exclusively on the fact that two-thirds of the patients with myxedema have radiologic enlargement of the cardiac silhouette. More recent physiologic studies have led to the appreciation that cardiac failure is not present and that the enlarged cardiac silhouette is due to pericardial effusion. The cardiac findings in myxedema which have led to the assumption that patients with myxedema have cardiac failure are listed in Table 1. Patients characteristically have exertional fatigue more than dyspnea. They may have angina partly due to associated coronary disease, and they have periorbital and peripheral edema. As radiographically viewed, the heart shadow is enlarged, but the weak and distant heart sound and the difficulty in palpating the apical impulse make an accurate determi-

TABLE 1.—*Cardiac Findings in Myxedema*

1. Exertional fatigue, dyspnea or angina pectoris.
2. Periorbital and peripheral edema.
3. Enlargement of cardiac shadow with:
 - a. weak and distant heart sounds
 - b. difficulty in finding apex beat
 - c. poor cardiac contraction to palpation and fluoroscopy
 - d. small pulse with slow carotid upstroke in face of bradycardia.
4. Relative bradycardia.
5. Effusions in pericardium, pleurae and peritoneum; tamponade rare.
6. Low voltage of QRS, T and P waves on electrocardiogram.
7. Hemodynamic findings:
 - a. decreased O_2 consumption
 - b. decreased cardiac output
 - c. decreased pulse rate
 - d. normal A-V O_2 difference.
 - e. normal response of cardiac output, systemic resistance, and right atrial pressure to exercise.

nation of heart size difficult. The pulse is small, with a slow carotid upstroke, indicating that cardiac contractility is impaired. This latter finding is particularly important because it occurs in the presence of bradycardia when a large stroke output and an increased carotid upstroke would be expected.

The bradycardia may be relative in patients with myxedema. A heart rate of only 60 to 70 would be an unusual finding in a patient with cardiomegaly and presumed congestive heart failure. Although patients may have effusion in the pericardial, pleural and peritoneal cavities, cardiac tamponade is rare. In one patient with myxedema, 4,000 ml of fluid was found in the pericardial cavity, yet the venous pressure was not raised and the patient had no clinical manifestations of tamponade. This indicates the pronounced distensibility of the pericardium if the accumulation of fluid is slow. Low voltage of the QRS complex, as well as the T and P waves, might suggest the presence of cardiac failure in patients with myxedema. Hemodynamic findings, however, demonstrate that patients with "myxedema heart" have decreased pulse rate, normal A-V oxygen difference and a normal response of the cardiac output, peripheral resistance and right atrial pressure to exercise.

Errors in Diagnosis of Myxedema

Errors in the diagnosis of myxedema fall into perhaps four different categories. (1) Because the clinical manifestations of myxedema are often slow and subtle, they are attributed to aging. The patient often seems to be getting older, a little more

tired, a little slower in his thought and movement. (2) Many patients are treated initially for anemia, which tends to be unresponsive to therapy. (3) A diagnosis of nephritis may be suggested by the periorbital edema and generalized serous collections of fluid. Because the edema does not pit, it is thought to be sub-nephritic, and the presence of proteinuria seems to confirm the diagnosis of nephritis. (4) Finally, the diagnosis of cardiomyopathy is often made in myxedematous patients because of the presence of cardiac murmurs and presumed cardiomegaly on radiologic examination.

The long time between the onset of symptoms and the diagnosis of myxedema should be emphasized. Often patients are observed by physicians for five to ten years before the diagnosis is made. In some reports of hypothyroid subjects it may be noted that clear-cut evidence of myxedema and enlargement of the heart shadow had existed for ten years before the diagnosis was made.

The symptoms and signs of myxedema are well known. Apart from the obvious ones there are two that are uncommon and perhaps not fully appreciated. One is the frequency of paresthesias, which in Wayne's⁸ series was 56 percent (in some others as high as 75 percent) and perceptive deafness, which occurred in about half the cases in the series. One interesting finding by Wayne was that the diminution in the lateral one-third of the eyebrows occurred as frequently in the population at large as it did in hypothyroid patients; this sign therefore is of no clinical value. Another symptom frequently helpful in diagnosis is hoarseness. On more than one occasion I have strongly suspected myxedema in a patient with heart disease entirely on the basis of his voice, although the coarse, dry skin changes are often obvious and helpful in diagnosis.

In one large series of cases, myxedema occurred spontaneously in 40 percent of the patients but in the remaining 60 percent it followed either I^{131} therapy or thyroidectomy. At the present time many more cases of myxedema are seen following successful I^{131} therapy, and it is feared that with the passage of time this proportion will rise progressively. When a patient is given I^{131} for thyrotoxicosis and the patient improves, the physician must be alert to the appearance of myxedema in the future.

The evidence that the clinical manifestations of myxedema are due to pericardial effusion rather than to cardiac failure has concerned a number of investigators. Table 2 outlines the evidence sup-

TABLE 2.—*Evidence That Pericardial Effusion Rather Than Cardiac Dilatation Is Responsible For The Enlarged Cardiac Silhouette In Myxedema.*

1. Rarity of clinical congestive failure (rare orthopnea, clear lungs despite apparent cardiac enlargement, no enlargement of liver, no raised venous pressure, no gallop rhythm).
2. Failure of digitalis and diuretics to produce diuresis.
3. Normal response to Valsalva.
4. Normal response of cardiac output, systemic resistance and right atrial pressure to exercise.
5. If pericardial fluid removed and air introduced, cardiac size normal.
6. Patients excrete a large salt load normally.
7. Enlarged cardiac shadow returns completely to normal after thyroid treatment, often within a month. Relapse occurs rapidly, often within a month when thyroid stopped.

porting the contention that the enlarged cardiac silhouette of myxedema is due to pericardial effusion rather than to cardiac dilatation. First is the rarity of clinical congestive failure. Physical signs such as orthopnea, raised venous pressure, enlargement of the liver and gallop rhythm are usually absent in myxedema. Furthermore, as demonstrated by today's first patient, despite an abrupt increase in the heart shadow no evidence of pulmonary venous congestion could be demonstrated. Digitalis and diuretics are usually ineffective. During the Valsalva maneuver, the square wave response of cardiac failure is not present in myxedema. McBrien and Hindle⁷ reported the case of a patient who did show a cardiac failure response to the Valsalva maneuver but did not respond to thyroid therapy and at autopsy was found to have independent heart disease. Following the removal of pericardial fluid, the cardiac size is usually found to be normal. Davies et al² showed that patients with myxedema can excrete normally a large salt load, while patients with congestive heart failure cannot. Last, of course, is the fact that the enlarged heart shadow returns completely to normal after

thyroid therapy, often within a month. Similarly, relapses often occur rapidly when thyroid therapy is stopped.

Table 3 outlines the hemodynamic data of Graettinger et al⁴ in patients with myxedema. The cardiac index is low and increased normally with exercise. There is no important abnormality of systemic resistance. In patients with myxedema systemic resistance fell rapidly with exercise whereas in patients with congestive failure it did not fall with exercise. The right atrial pressure increased with exercise in patients with cardiac failure, but did not change with exercise in patients with myxedema. The cardiac index in myxedema was found to be one-third that in patients with thyrotoxicosis.

In conclusion, the evidence seems quite convincing that pericardial effusion, rather than cardiac failure, is responsible for the large heart shadow in myxedema. The mechanism by which pericardial effusion is produced has never been completely explained. One theory¹ asserts that a mucopolysaccharide complexed with protein exerts osmotic effects within the pericardial sac leading to pericardial effusion. There is also increased capillary permeability because the protein concentration of these fluids is very high.

One remark concerning therapy: The response is very dramatic but may be dangerous. The tendency of many physicians is to administer too much thyroid extract in an attempt to reverse the situation quickly. Severe angina, acute myocardial infarction, cardiac failure, psychosis and ventricular tachycardia may develop within 24 to 72 hours of treatment. It is very important to initiate therapy with a small dose of thyroid extract, perhaps 25 μ g of thyroxine, 5 μ g of tri-iodothyronine or 15 mg of dessicated thyroid. Improvement will occur within days with synthetic compounds, and, unless the patient is threatened with coma, there is no

TABLE 3.—*Comparison of Hemodynamic Data: Hypothyroidism vs. Congestive Failure*

	Hypothyroid n=12		Heart Disease with Failure n=7	
	Rest	Exercise	Rest	Exercise
O ₂ consumption (ml./min./M ²)	87 ± 3	188 ± 18	138 ± 9	202 ± 17
Cardiac Index (L./min./M ²)	1.88 ± 0.07	3.05 ± 0.22	1.93 ± 0.12	2.11 ± 0.20
Stroke volume index (ml./beat/M ²)	30 ± 0.5	39 ± 0.5	19 ± 1	17 ± 1
Heart rate (beats/min.)	64 ± 3	79 ± 5	103 ± 5	122 ± 4
A-V oxygen difference (ml./100 ml.)	4.66 ± 0.15	6.15 ± 0.34	7.18 ± 0.42	9.83 ± 0.51
Systemic resistance (dynes cm. sec. ⁻⁵)	2577 ± 183	1733 ± 160	2345 ± 204	2518 ± 368
Right atrial pressure (mm. Hg)	6 ± 1	7 ± 1	10 ± 3	21 ± 3

(After Graettinger, 1958)

urgency to reverse the situation abruptly. The harm of too rapid reversal is great.

DR. SMITH: I think we have time for questions or comments.

Question from audience: How extensive is the evidence that cardiac hypertrophy is associated with thyrotoxicosis?

DR. SOKOLOW: There is a good deal of experimental evidence. In animals cardiac hypertrophy can be produced with thyroxine treatment⁷ and in man a complete cure of cardiac failure can follow treatment with antithyrotoxic drugs.

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SPINAL HYPOTENSION DURING CESAREAN SECTION

How should you treat spinal hypotension in women undergoing cesarean section?

"My first choice is to push the uterus off to the left. Ninety to ninety-five percent of the mothers will respond to this easily and with no trouble at all. Oxygen always. I am not too sure what this does, but it is good for the mother and good for the anesthesiologist and the obstetrician. A vasopressor I will use in the rare instance when uterine displacement doesn't raise the blood pressure . . . or I will use it when I feel that I cannot keep the uterus off to the left. If I am going to push it off to the left and go do something and then the blood pressure falls right back down again just as soon as the uterus leans on the vena cava again, this is not going to be worthwhile. The babies will do far worse than if you use a vasopressor straightforward or keep the uterus off to the side. So if you can, if you have an extra hand, and you can keep it over there, I would say this is the better technique; if you cannot assure a continuous uterine displacement to the left, then use a vasopressor. What I do is give 25 mg of ephedrine intravenously once, or twice if the first dose doesn't quickly correct the hypotension. I rarely use intravenous fluids other than whole blood, if that be necessary. Postural technique is of interest, but it's often hard to do a cesarean section with the woman's legs up in the air or with the woman on her side."

—FRANK MOYA, M.D., Miami, Florida
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